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Airborne Instrumentation System (AIS) for Electronic Combat Test and Evaluation: Concept and Validation

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PREFACE

This document was prepared by the Institute for Defense Analyses (IDA) for the Director, Operational Test and Evaluation, in partial response to the task Assessment of Electronic Warfare Systems. The objective of this effort was to summarize the concept and results of the use of the Airborne Instrumentation System (AIS) for electronic combat test and evaluation. The AIS was funded by the Resource Enhancement Program (REP) and sponsored by DOT&E. This paper will be presented to the International Test and Evaluation Association (ITEA) workshop "Modeling and Simulation – 1996 and Beyond ... Are We Progressing?" on 9 through 12 December 1996.

The IDA Review Committee consisted of Mr. Thomas P. Christie, Director of the Operational Evaluation Division, and Dr. Alfred E. Victor, project leader for the task, who also provided technical oversight.

AIRBORNE INSTRUMENTATION SYSTEM (AIS) FOR ELECTRONIC COMBAT TEST AND EVALUATION: CONCEPT AND VALIDATION

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A. THE PROBLEM WITH GARLIC

One of the fundamental difficulties in the test and evaluation (T&E) of an electronic combat (EC) system is that it is a "soft-kill" device. EC is very much like vampires and garlic; if you wear a garland of garlic around your neck and are not attacked by a vampire, you can claim that it was the garlic that prevented it. However, you will have a difficult time convincing the skeptics. Similarly, at the end of even the most authentic test of an EC component, there is often no hard evidence that the component functioned properly.[1] At most, there may be some negative evidence that something was not right; for example, a missile might shoot down a drone equipped with the system. But proving that an EC component failure caused the drone to be shot down is difficult. Therefore, to test an EC component adequately, a substantial amount of information must be gathered about the test environment and the response of the system under test.

One of the most significant problems in addressing this requirement is the lack of adequately instrumented aircraft. A limited number of instrumented aircraft dedicated to testing do exist, but the instrumentation is expensive and often intrusive. There also is a strong desire to use combat representative aircraft during some portions of testing, particularly the latter phases of operational test and evaluation (OT&E). Unfortunately, the instrumentation of these aircraft typically consists of videotape recorders and kneeboard cards. The data are incomplete, time consuming to reduce and analyze, and make unambiguous correlation of environmental stimuli and system response impossible.

Complicating the instrumentation problem further is the variety of data collection, reduction, and analysis procedures, often created from scratch, to suit the peculiarities of each test. Even within the same acquisition program, data are rarely collected, reduced

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1 Or improperly, for that matter. No EC system is perfect, and a kill by a threat system does not prove that the EC system failed. (A test in which the platform is killed every time is pretty convincing, however.)

and analyzed consistently in all phases of the test. This leads to disagreement over the system's performance in different test program phases.

Many of the existing data collection, reduction, and analysis processes require a week or more before the data are available for initial review. Often several more flights have occurred, which means that a flawed portion of the test may continue to invalidate several more missions before it is detected. In several recent EC operational tests, serious flaws in the instrumentation or data reduction have caused the loss of up to half of the data collected.

B. THE NEED FOR A SOLUTION

To address the EC test data collection problem, a multi-Service ("purple"), multi-platform, multi-system package for aircraft instrumentation that is non-invasive, flexible and easy to use, and able to provide quick-look results is needed. Ideally, it should provide non-invasive and selective aircraft bus monitoring and require minimal or no modification of all operational aircraft of interest. It should be able to operate independent of the test range infrastructure and yet provide accurate position information. It should be easy to configure and verify its correct operation. Its use should have minimal impact on pre-flight and post-flight procedures. The supporting and analysis software should be usable for mission visualization, simple automated processing, and in a more detailed mode allowing alternate analyses of the data.

C. A SOLUTION – THE AIRBORNE INSTRUMENTATION SYSTEM (AIS)

After witnessing several inadequate tests in the EC OT&E testing area, the Director of Operational Test and Evaluation (DOT&E) in OSD decided to develop a system of hardware and software to address these needs. The system is the Airborne Instrumentation System (AIS). The initial focus for this "purple" pod was for the T&E instrumentation needs of any EC system; in the future, it could be used for other avionics systems. In its present configuration, it is composed of two pieces of hardware to cope with different aircraft installations, a flightline computer, and three software components. The external Test Instrumentation Pod (TIP) was designed and built by Metric Systems Corporation and is based on a P4B Air Combat Maneuvering Information (ACMI) pod. Five were built as part of the AIS program. The internal Alternate Data Acquisition System (ADAS) is based on a Canadian design (the Record All Small Data Acquisition System (RASDAS)); only one of these was assembled by W.J. Associates. The software was developed by the 96th CCSG/SCWA, Eglin Air Force Base (the "Math Lab").

Sponsorship for the program is provided by DOT&E, supported by IDA and life cycle support is being provided by the 96th CCSG/SCW at Eglin Air Force Base.

Independently of the AIS program, COMPTEK Systems developed the Digital Bus Recorder System (DBRS), another internal recorder. The data from this system is compatible with the software developed by AIS.

D. GENESIS OF AIS

The idea for the AIS originated with a software/hardware combination developed by Georgia Tech Research Institute (GTRI). Based on a modified USAF general instrumentation pod, the Digital Flight Recorder (DFR) includes a Coarse/Acquisition (C/A) code Global Positioning System (GPS) receiver and antenna, processor, static RAM, and an interface with the aircraft MIL-STD-1553 bus. The DFR could be rapidly loaded/unloaded from an aircraft and was easily configurable from a portable PC. The data could be downloaded to the same PC at the end of the flight and imported into GTRI's Automated Data Reduction System (ADRS) software, together with threat simulator on/off data, and analyzed the same day the mission was flown.

There are several significant problems with the hardware and software, particularly for the joint Service use requirement. The DFR is 16 inches in diameter and weighs approximately 450 pounds, significantly impacting aircraft flying qualities. The early generation GPS receiver is prone to dropouts in reception of the GPS signals. The ADRS software is limited to analyzing tightly constrained missions because of a very limited representation of emitter activity. The stimulus-response algorithm does not include emitter radio frequency (RF) parameter correlation or whether the aircraft was within the emitter's beam. The software does not allow for flexible data import or export. The software is undergoing a significant upgrade that may address these issues.

E. CONCEPT OF USE FOR AIS

A more general concept, based on the GTRI approach, was developed for AIS, as illustrated in Figures 1 and 2. Figure 1 shows the use of AIS at any test range with emitters illuminating the aircraft. The AIS collects MIL-STD-1553 bus data from an on-board radar warning receiver (RWR) (or other avionics system), GPS position data and inertial position and attitude data from either the aircraft or an AIS sub-system. Likewise, for data correlation, the emitters illuminating the aircraft collect data on their

CONCEPT OF USE – PART I

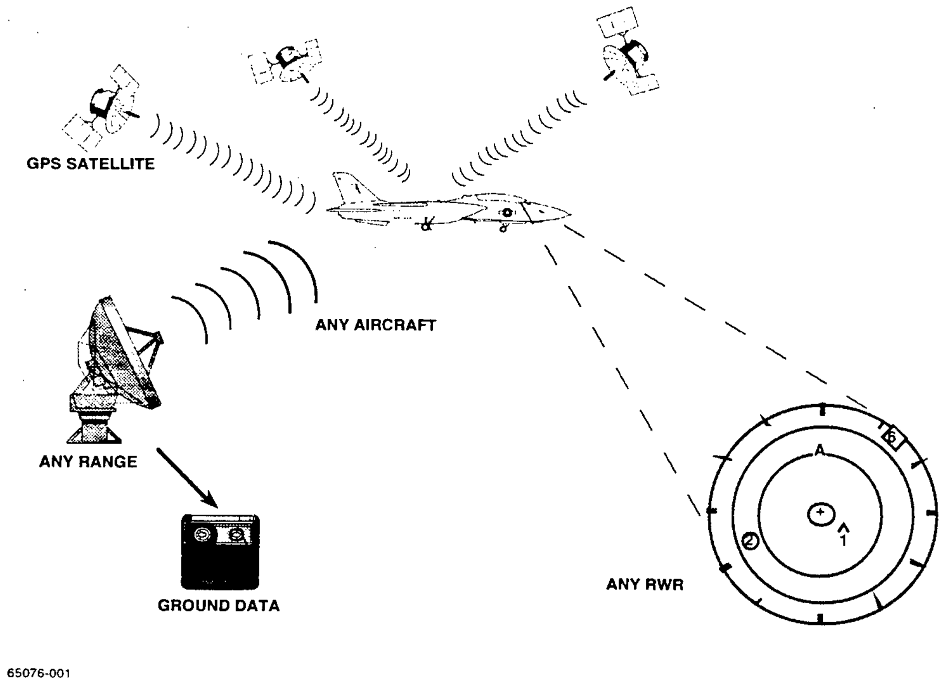

Figure 1. TIP Use During T&E

CONCEPT OF USE – PART II

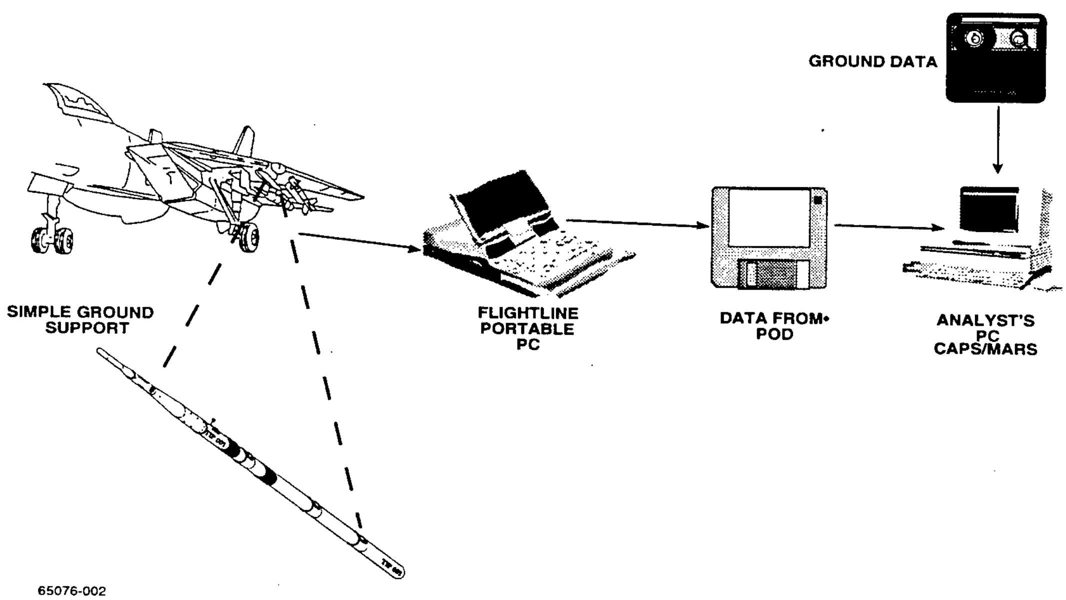

Figure 2. Data Path from TIP to Analyzed Data

modes and pointing angles tagged with GPS time. If data correlation is less important, emitter on and off times may be logged by hand and normal operating ranges assumed for emitter RF parameters. After the aircraft lands, the data are downloaded with a removable medium. These data are translated into engineering units, combined with emitter truth data, and analyzed on a PC. Depending on how fast the emitter data can be gathered, analysis of the data can begin as early as a few hours after the aircraft lands. The system is modular so that components can be replaced or omitted, such as using a different data recorder or using test range time, space, and position information (TSPI) data versus data collected on-board or omitting aircraft attitude data, without causing the process to collapse.

F. DESCRIPTION OF AIS COMPONENTS

1. TIP Hardware

The TIP is based on a modified ACMI P4B instrumentation pod (it has similar form, fit and moments of inertia as an AIM-9) that has had several components removed (see Figure 3). In their place an all-in-view GPS receiver using the existing antenna, a high-reliability fiber optic gyroscope (FOG) inertial measurement unit (IMU), and a navigational processor unit (NPU) for producing smoothed position data have been added. An Intel-based Digital Interface and Processor Unit, using information stored in a configuration file, is used for filtering and managing the TSPI data and two dual-redundant 1553 buses. All data are stored on two removable Personal Computer Memory Card Industry Association (PCMCIA) cards (total current capacity 80 MB) stored in the rear of the pod. These allow for rapid data downloading, high capacity, and simple declassification of the TIP. The rear of the pod has been modified to incorporate an indicator light for pod built-in test (BIT) results, a connector for uploading configuration files, and a PCMCIA card drive and cover. The ACMI transponder was retained, allowing the pod to function as an ACMI pod. Unlike current ACMI pods, it will have recording capability and GPS position data in case data drop-outs corrupt the telemetry data. When functioning as an ACMI pod, the TIP will be able to act as a 1553 remote terminal as well as a bus monitor. The transponder can be disabled for compatibility or security reasons via the configuration file.

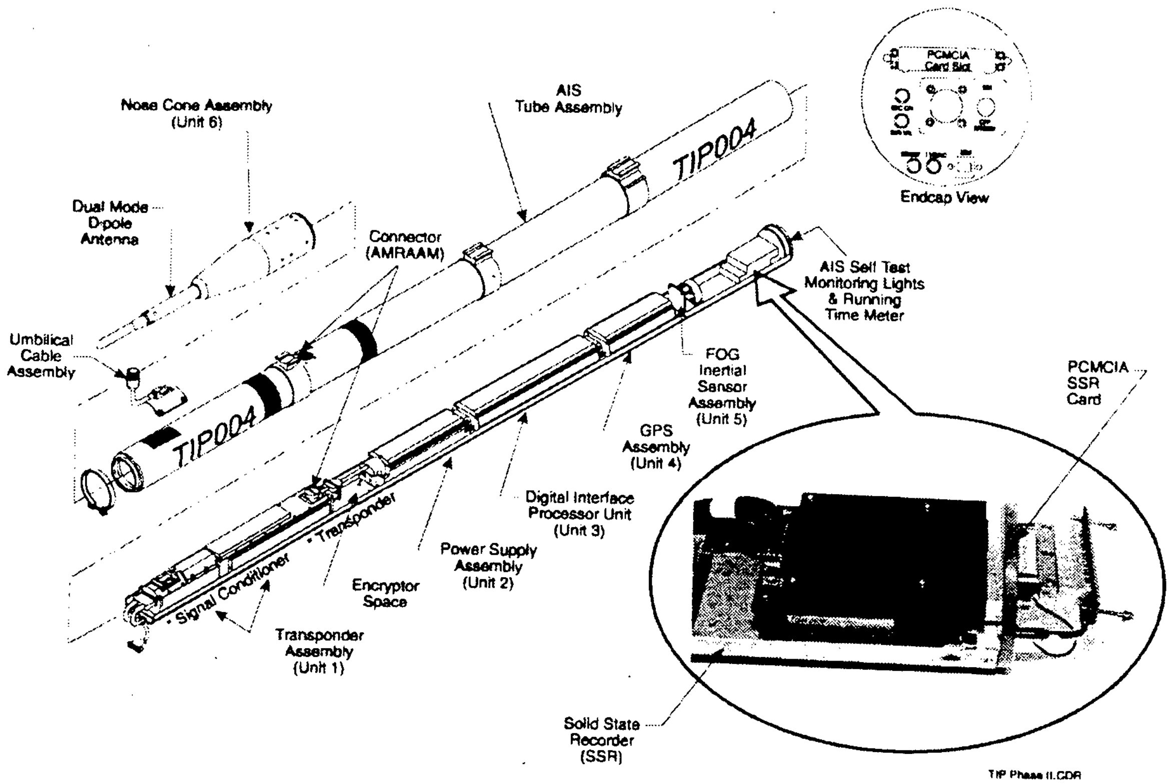

Figure 3. AIS TIP Components

The TIP mounts to a standard LAU-7 missile launcher and uses standard cabling. If EW bus data are available at the weapons station, no modification to the aircraft is required. Otherwise, a wiring modification must be made or a different recording system form factor must be used (see below for the approach taken for the F/A-18). On the F-14D, this modification requires a single cable and approximately two hours to install. It can be left in until that weapons station is needed for a weapons delivery, then removed.

The GPS receiver is a 12-channel C/A code NovAtel model 3151 receiver. Although the signals from only four satellites are needed to produce a TSPI solution, the additional channels are used to track extra satellites so that the best four satellites can be used to calculate a solution under all conditions. The additional satellites are also useful so that if a satellite being used for the current solution drops out of view, another will be available immediately to incorporate into the solution. Finally, if as many as eight or more satellites are available, they can be used to produce a second solution that can be used to provide quality estimates on the primary solution.

The GPS receiver and the FOG IMU are loosely coupled via the NPU to produce an aided absolute solution, replacing the original ACMI pod inertial sensor assembly. The FOG is a very reliable system since it has no moving parts and is likely to become the standard inertial data source for GPS aiding. GPS receivers and IMUs have complementary strengths. GPS receivers produce very accurate position data, but are prone to high frequency and large amplitude errors and have a low data rate, whereas an IMU is subject only to a very low frequency drift, allows coasting during loss of GPS receiver lock, and can produce data at a higher rate. Together they allow the calculation of a Method 3 differential aided solution post-mission using a reference receiver.

2. ADAS Hardware

The Alternate Data Acquisition System (ADAS) system was designed as an interim instrumentation system to fill a need for an internal bus recorder on the F/A-18. The ADAS is also a potential solution for bus instrumentation on other aircraft where accessing the desired 1553 data bus at a weapons station is not possible, or where carrying an AIM-9 form pod is not possible. In normal operation it is complemented by a TSPI data source (external GPS pod or test range tracking systems). It consists of a Merlin data encoder for converting 1553 data into RS-170 video format for recording on a videotape recorder (VTR), an IRIG-B time code generator and a TEAC Hi-8 millimeter VTR (providing two hours of recording time). These components (plus a power conditioner) are packaged for mounting inside the gun bay access door without displacing the gun, ammo tray or any other systems. The gun bay location was chosen because several 1553 buses (weapons, avionics, and EW) have connections there.

Recording begins at power up. The time synch for the IRIG time code generator is provided by a temporarily connected hand-held GPS receiver. Upon mission completion, the Hi-8 millimeter tape is removed and taken to a computer equipped with an Advanced Bus Interface (ABI) Protocol Analysis Simulation System (PASS) PC card and PASS 1000 software (manufactured by SBS Engineering). A Merlin decoder and VTR are used to replay the data into the computer where it is decoded and the desired 1553 messages are selected. This ground station can be used also as a bus monitor directly connected to an aircraft 1553 bus (for diagnostic use on the ground). The data can then be translated by Common Airborne Processing System (CAPS) and analyzed by Mission Analysis and Reporting System (MARS) or other analysis packages.

3. COMPTEK DBRS Hardware

Since ADAS has some fundamental limitations (no data filtering capability on record, no remote turn on capability, limited recording time), other internal systems were considered for future development by the AIS program. A functional design similar to the TIP pod including a processor for filtering, managing data, and PCMCIA card storage was considered. Before funding could be located for this, COMPTEK Systems designed the Digital Bus Recorder System (DBRS) exactly fitting these specifications. Substantially smaller than the ADAS, it can fit also in the gun bay of an F/A-18 and uses an external time synchronization. Rather than an IRIG-B time card, the DBRS uses the clock on the Motorola 68030-based logic board, which allows a drift of about one second per day. The current configuration consists of a single 170 MB PCMCIA card. Two of these systems were purchased by AIRTEVRON 9 at China Lake, one of the Navy's test and evaluation squadrons. Because of this, the DBRS has been included in the list of recorders compatible with the AIS software components.

4. AIS Software/Support Systems

Several pieces of software have been developed under the AIS program to assist in the uploading and downloading of data, translation of the data into engineering units and standard formats, analysis, and reporting. Metric developed the upload software for the modification of the TIP configuration file that controls what data are recorded and at what rate. 1553 data can be filtered down to the remote terminal address, subaddress, and word level. M out of N sampling is allowed to reduce the data rate from some systems (inertial data in particular).

Three pieces of software have been written or significantly modified by the Eglin Math Lab to translate, correlate, and reduce the data from the recorders: the Common Airborne Processing System (CAPS), the Mission Analysis and Reporting System (MARS), and the GPS analyst software.

CAPS is a general purpose data translation program for converting binary data to formatted data with engineering units. It uses a modular architecture to allow additional bus data formats to be interpreted and additional output formats to be specified. Currently, CAPS interprets IRIG PCM Class I/II, MIL-STD-1553 message data, and several GPS receiver formats. A system-specific data dictionary specifies the translation to be performed for all recorded messages. It identifies the command word, word and bit ranges, the binary data type (e.g., two's complement), and the proper conversion factor to be applied to translate each item. The information to produce this data dictionary should be contained in a system's Interface Control Document (ICD). Once the data are imported and translated in CAPS, subsets can be selected and exported using Output Product Description files (OPD) to specify the variables, order, format and delimiters best suited for the analysis. The dictionaries and OPDs can be created by the user. In some cases, where the relationships between the variables are complex, a dynamic link library (DLL) file must be used to process some of the data during the export step.

MARS is an RWR and self-protection electronic countermeasures (ECM) system analysis program that was first developed for the F-15 Tactical Electronic Warfare System (TEWS) program to analyze the RWR and jammer test results. The jammer analysis capability was developed first, with the additions to the RWR capability added more recently. Much of the future capability to be added will be in the RWR area.

MARS requires data to be formatted in predefined database tables containing information on threat system actions, aircraft position and attitude, and system response for each mission. Depending on the analyses to be performed, several supporting tables may also be required that identify emitter locations, emitter RF characteristics, and translation tables for system response (e.g., RWR symbol data table and threat pointer table). Standard database operations such as record exclusion, sorting, searching, exporting subsets of data, and calculations on various fields can be performed. MARS includes a variety of jammer and RWR analysis methods, including:

- RWR display simulation with user editable characters and enhancements
- Polar and strip chart plots of any numeric fields
- SAM/AAA shot analysis (including AAA burst analysis)
- Computation of reduction in hits and survivability measures
- Correlation of RWR response to threat signal characteristics
- Response time/symbol ageout time/detection range analysis
- RWR Direction Finding (DF) error analysis (numerical and graphical)
- Non-parametric statistics on any field
- Tracking error statistics.

To make the various RWR analyses possible, MARS has a flexible correlation capability. PRI, frequency and pulse width as measured by the RWR can be correlated in any logical combination with a database of known emitter characteristics. RWR azimuth, threat tracking error, and threat activity (on/off) data can be included in the correlation also.

As a QA method and for immediate feedback on RWR performance, a simulated display with the displayed symbols and enhancements is available. The specific displays of several Air Force and Navy RWRs have been created so that the appropriate symbology and range rings can be seen.

The final software component, GPS analyst, integrates GPS and IMU data for the aircraft position with data from a ground-based reference receiver to produce Method 3 aided differential GPS solutions for aircraft position when more accurate TSPI data are needed. The output of this program can be used by MARS for EC system analyses.

G. RESULTS OF AIS TESTING TO DATE

The AIS and the supporting software have been in almost continuous use for the last two years. As is common in system development, there have been some problems, some of which were outside the control of the AIS. However, they do reveal the kinds of issues that have to be addressed. The robustness of the AIS concept has been demonstrated also. Portions of the AIS have been used on eight different aircraft in two years.[2] The following is a summary of the results from these tests.

- The TIP/CAPS/MARS combination produces results identical to those captured by an All-Bus Recorder and the standard Patuxent River data reduction process on an instrumented F-14D.
- A C/A code GPS receiver with Inertial Navigational System (INS) aiding and differential correction can provide accuracies better than 30 feet under high dynamic conditions.
- GPS time and UTC differ by a number of leap seconds that changes roughly yearly. It is currently 11 seconds.
- All test data should be examined immediately after every mission. Even though AIS gives this capability, several costly mistakes were made when this capability was not taken advantage of.
- Even reference systems break and have errors that must be accounted for in comparisons. Several AIS calibration tests had to be repeated because the reference systems failed.
- The data recording, reduction, and analysis chain must be validated from start to finish prior to the start of every test phase. The entire chain with the

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2 Aircraft (and EC systems) tested to date include F-16C Block 40 (ALR-56M), F-14D (ALR-67E (V)2 and ASPJ), US and Canadian F/A-18 (ALR-67E (V)2 and ALR-67 (V)3), UH-1N (APR-39A), and German Air Force F-4, Tornado, and MiG-29.

AIS was not fully exercised until late in the testing, which revealed a number of previously undetected problems.

- MARS needs further development to be able to analyze data adequately in a complex environment or for systems that make coarse measurements of the RF environment. In addition, the MARS software still has a steep learning curve and does not provide sufficient quicklook capability. These issues are being addressed in upgrades this fiscal year.
- CAPS has proven itself to be a very flexible data translation tool. For example, ALR-67 (V)3 data from two different recorders were collected over two weeks at Patuxent River's Air Combat Environment Test and Evaluation Facility (ACETEF) chamber. The data from both recorders were translated and analysis begun two days after the first data were collected.

H. LESSONS LEARNED DURING DEVELOPMENT

Some important issues have surfaced while developing the hardware and software components for the AIS. These issues are generic to this sort of instrumentation system and not specific to AIS. They will have to be faced for each new aircraft and/or new system to be instrumented with the AIS or any similar system. Although they appear to be simple lessons, experience shows that they bear repeating.

- A flexible system architecture that accommodates multiple hardware and software configurations is essential. The second aircraft examined by the AIS program, the F/A-18, cannot be conveniently instrumented with the external TIP since no solution for bringing electronic warfare (EW) bus data to a weapons station has been found.
- 1553 bus data were not intended to be translated by normal humans. The ICDs to translate these data can be difficult to obtain and are difficult to interpret unambiguously. For each new system to be tested, or each major OFP upgrade, several man-weeks must be spent up front developing a CAPS data dictionary from the ICD to translate the data into engineering units. This is still substantially less time than developing a data analysis package from scratch.
- Simple operational problems can defeat the best technology. The data from several sorties were lost because of systems not being turned on or being incorrectly connected.
- Any universal instrumentation and analysis system must prove its worth by being easier and less expensive to use than existing solutions. Just being a "standard" is not enough.
- To produce adequately stable TSPI results, a GPS receiver must be aided by an IMU for high dynamic maneuvers. However, integrating a GPS and IMU

system is still an art form, and requires many revisions. Several of the early TIP tests revealed significant problems in this area.

- Although CAPS and MARS are being designed to reduce and analyze data from a wide variety of systems, experience to date has shown that every system has some peculiarity that requires additions or modifications to the CAPS/MARS data reduction/analysis process. To date, once these peculiarities are identified, solutions have been available. Any universal system will have to deal with such problems.

I. FUTURE PLANS AND POSSIBILITIES FOR AIS

There are plans to substantially improve CAPS, MARS and GPS analyst this fiscal year. The upgrade of CAPS to version 2.0 is fully funded and will ship May 1997. It will include the capability to handle more binary data types, the ability to work in a variety of data formats rather than importing into a standard format (thus saving time), and more robust capabilities to examine translated data for verification that the translation has gone correctly.

Several phases of upgrades to MARS are being considered. As currently envisioned, the first phase would include a number of usability and functionality improvements to ease analysis of a broader range of systems, with the primary addition being a "smart" simulated RWR display with truth data displayed for reference. The second phase would be the addition of a robust scenario map function to ease qualitative analysis of the data and integrate data from the many tables in MARS into a single display. The final phase would be an overhaul of the correlation function and support file structure to allow even more robust matching of RWR-measured signal characteristics with test range truth data. The first two phases of this plan may be funded shortly, the final phase is unfunded. Also currently unfunded is the completion of the capability to include the emitter activity and position information for up to 10 airborne threats.

The GPS analyst upgrades are still being determined. They will focus on broadening its capabilities to incorporate TSPI data from a variety of sources rather than just GPS and integrating them with the Advanced Test Data Optimal Processor (ATDOP). Future development of the AIS will depend on the requirements of the development and test communities.

1. Possible Future Uses of AIS

Although the focus of the AIS development has been on instrumenting and analyzing EC systems under test, the availability of an easy to use bus recorder, stand-alone TSPI source, and independent data reduction and analysis capability suggest several other possible uses.

- Instrumenting the fire control radar (FCR) messages on aircraft that are acting as interceptors during a test. The EC system response could be accurately correlated to the FCR activity using CAPS/MARS.[3]
- The AIS could act as a poor-man's intelligence gathering device, allowing quick looks at RF parameters gathered from targets of opportunity.
- The ACMI message format contains a number of spare words. By monitoring both the EW bus and the weapons bus and using the ACMI capability of the TIP, information about the EC system under test could be included in the standard ACMI messages.

J. CONCLUSION

The AIS is becoming the multi-Service, multi-aircraft, multi-system instrumentation solution that it was designed to be. A number of roadblocks have been overcome along the way. Although the initial goal of non-invasiveness has not been completely met, until aircraft are designed to be non-invasively instrumented, any similar system will face the same problems. With AIS, the evaluation procedures need not be redesigned for every EC system test. AIS is very flexible, as illustrated by the number of aircraft and systems on which it has been and will be used. Finally, with the development of CAPS/MARS, when some pre-test work has been done specific to the aircraft and system under test, rapid turnaround has been demonstrated. When AIS is used to support EC T&E, it improves the quality of the evaluation and permits standardization throughout the test process.

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[3] MARS 3.2 does not have the capability to correlate airborne interceptor actions to EC system responses. Some of this capability has been developed, but completion of this upgrade will likely require sponsorship from a program needing this analysis.

APPENDIX A

ACRONYMS

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ACRONYMS

AAA	Anti-Aircraft Artillery
AAM	Air-to-air Missile
ABI	Advanced Bus Interface
ACETEF	Air Combat Environment Test and Evaluation Facility
ACMI	Air Combat Maneuvering Information
ADAS	Alternate Data Acquisition System
ADRS	Automated Data Reduction System
AIS	Airborne Instrumentation System
ATDOP	Advanced Test Data Optimal Processor
BIT	Built-in-Test
C/A	Coarse/Acquisition
CAPS	Common Airborne Processing System
DBRS	Digital Bus Recorder System
DF	Direction Finding
DFR	Digital Flight Recorder
DLL	Dynamic Link Library
DOT&E	Director, Operational Test and Evaluation
EC	Electronic Combat
ECM	Electronic Countermeasures
EW	Electronic Warfare
FCR	Fire Control Radar
FOG	Fiber Optic Gyroscope
GPS	Global Positioning System
GTRI	Georgia Tech Research Institute
ICD	Interface Control Document
IMU	Inertial Measurement Unit
INS	Inertial Navigational System
MARS	Mission Analysis and Reporting System
NPU	Navigational Processor Unit
OPD	Output Product Description
OT&E	Operational Test and Evaluation

PASS	Protocol Analysis Simulation System
PCMCIA	Personal Computer Memory Card Industry Association
PRI	Pulse Repetition Interval
RASDAS	Record All Small Data Acquisition System
RF	Radio Frequency
RWR	Radar Warning Receiver
SAM	Surface-to-air Missile
T&E	Test and Evaluation
TEWS	Tactical Electronic Warfare System
TIP	Test Instrumentation Pod
TSPI	Time, Space, and Position Information
UTC	Universal Coordinated Time
VTR	Videotape Recorder

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13. ABSTRACT ***(Maximum 200 words)***

Test and evaluation of aircraft electronic combat (EC) systems has been hampered by numerous data collection and analysis problems. To improve this situation, a multi-Service, multi-platform, multi-system instrumentation package that is non-invasive, flexible and easy to use, and can provide quick-look results is needed. Beginning in FY94, OSD/DOT&E funded, through CTEIP/REP, the design, construction, and testing of the Airborne Instrumentation System (AIS). AIS consists of two aircraft instrumentation packages, one for external and one for internal use (TIP and ADAS), a flightline computer for data upload/download and reconfiguration, and data reduction and analysis software (CAPS and MARS). Together with test range threat emitter instrumentation (to provide on/off times and track errors), these components form a complete system for T&E of EC systems. AIS has recently undergone flight testing and validation; it was used by IDA and OPTEVFOR for the evaluation of the AN/ALR-67E (V)2 RWR during FY96 and the GPS/INS subsystem was validated at Eglin AFB by the 96th CCSG/SCW, also during FY96. The design concept, validation results, and potential test applications of AIS are described in this paper.

14. SUBJECT TERMS
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